

Early Maturity and Acid Soils Tolerance Maize Lines Performance In West Sulawesi Indonesia

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ABSTRACT. Maize productivity increasing in Indonesia must be effort to keep up high demand. Expansion maize growing in acid soil will be a big potential, but acid soil degree in this area is the main constrain to produce maize. Create hybrid lines as new candidate varieties which appropriate in the acid soils is the ones choice. Yield productivity of maize lines which tested is early maturity acid soil tolerance. Research was conducted in Tappalang District Mamuju Regency West Sulawesi from May-August 2010. The research arranged based on randomized block design, treatments consist of 9 pure maize lines and 2 early maturity hybrid maize (AS-1 and Bima-3 Bantimurung) and 1 open pollinated maize (Sukmaraga) as the acid soil tolerance check. So there were 12 treatments and 3 replications. This research fertilized of 300 kg urea ha^{-1} + 200 kg phonska ha^{-1} + 100 kg KCl ha^{-1} . The results showed that there were 5 hybrid maize lines produce grain yield more than 7 ha^{-1} and not significantly different to AS-1 (7.83 ha^{-1}), Bima-3 Bantimurung (7.30 ha^{-1}) as early maturity cultivar check, and Sukmaraga (7.42 ha^{-1}) as acid tolerant cultivar check. The promising maize lines is GM1, GM2, GM3, GM8 and GM9 which grain yield potential is 8.05 t, 7.70 t, 7.99 t, 8.15 t and 7.90 t/ha respectively.

Key words: Hybrid lines, Early maturity, Acid soil, Productivity, Maize.

Introduction

Grain maize demand increasing agree with population adding by many kind of necessary. Maize predominantly used for raw material of feed industry. Indonesian maize production in 2008 reached 18.317.252 ton is just enough to fulfill national maize demand, but it couldn't be sustainable in 2009 caused by maize national production decreasing until 17.8279.748 ton (BPS 2009). Therefore Indonesia must be import grain maize about 330 ton especially raw material for feed industry.

To fulfill the big maize demand consequently increasing maize productivity must be effort continued. Mean while fertile land for supporting intensive agriculture in Java is limited due to as alternative is using marginal land outer of Java for maize production (Fagi 2007). Marginal land most potential based on large area is the acid soil especially on pH 4-5 where spread in Sumatra, Kalimantan, Sulawesi and Papua. High potential of acid soil in those islands based on wide area that estimated 45.794.000 ha (Puslit Tanah 2009). The main constrain to expand maize in this area was less fertility of soil caused by low pH and high Al concentration in soil solution. High concentration Al poisoning for maize through disturb root that blocked water and nutrient absorb, advanced decrease plant development and grain yield. Maize tolerance to < 40% Al saturated (Sanchez 1976). For instance Ultisols in south and East Kalimantan Al saturated vary of 33-95% (Subagio *et al.* 2004).

Several years lately global warming phenomenon run down the world and very influence to drought, exceed or lack rain fall, and air temperature increasing affected to decreasing plants productivity (Irianto 2009; Agrawal 2010). Early maturity acid tolerance maize necessary planted to anticipate global warming phenomenon. In generally early maturity maize we have just now is local and composite trait, ie: local Ciamis, Kodok, Ppool-2 and Florida flint synt by low grain productivity, therefore needed to create hybrid variety as the higher yield potential. Mean while maize planting in Indonesia 2008/2009 dominated by hybrid 57%, composite 16.78%, and local 25.80% (Balitsereal 2010). Such as create early maturity acid soil tolerance maize is the ones way caused by low cost, easy to implemented and efficient to expansion in acid soils. Liming practices just a long time in acid soil to decreasing soils pH, but very difficult implemented of farmer level. Actually liming aimed to increase pH, so the nutrients more available for plant especially P and decreasing Al poisonous of plant (Hardjowigeno 2007).

Materials and Methods

Material consisted of 9 pure maize lines were planted 1 set F1 hybrid from linix tester crossing method ie: GM1, GM2, GM3, GM4, GM5, GM6, GM7, GM8, GM9 and three cultivar ie: Bima-3, AS-1 dan Sukmaraga. AS-1 as early maturity check and Sukmaraga as acid soils tolerance

check. Pure lines were adapted test in acids soil of Tappalang Village, Mamuju Regency West Sulawesi on May-August 2010. Soils sampling at view site composite and analyzed at Soil Laboratory and Chemical Services of ICERI (Indonesian Cereals Research Institute) before maize lines planting. Hybrid Lines and cultivar maize as the control planted on 5 m x 3 m plot size with 70cmx20cm plant distance and arranged in randomized block design three replications. Fertilized by 300 kg/ha + 200 kg/ha SP36 + 100 kg/ha. Dosage 50% urea and KCl plus whole SP36 applied 7 days after planting (dap). Urea and KCl remains 50% applied 30 days after planting (dap). Carbofuran used to control stem borer by dosage 10 kg/ha apply top leaf on 35 dap.

Grain yield in kg/ha estimated with formula:

$$\text{Yield (kg/ha)} = \frac{10000}{\text{HW}} \times \frac{100 - \text{WC}}{100 - 15} \times \text{SW} \times 0.80$$

WC = Water content in harvesting

HW = Harvested wide (m²)

SW = Sample weight (kg)

0,80 = Grain percentage of cob (rendemend)

Data Collection

Data collecting include age of tasseling (50% pollen shed open), plant height (cm), ear height position (cm), ear weight (kg), grain water content (%) in harvested, 100 grain weight, and grain weight (t ha⁻¹), ear long (cm), ear diameter, plant performance (scoring) before harvesting, husk cover (scoring), and rendemend (%).

Results And Discussion

Soil Properties

Soils fertility status in research location is clay texture, acid reaction, low organic matter content, low total N, very low P, high K and Ca, high cation exchangeable and high base saturated. Nutrient condition of soil in research site is fertile enough for maize growth, but low N and P that necessary adding of both nutrients to achieve optimum grain yield of maize. Whereas N, P is macro nutrient of plant including maize. They need in large number and frequently is the main limiting factor of maize production (Table 1). Engelstad (1997) reported that applied optimum N could be increase: plant growth, protein synthesis, chlorophyll formation, and stem root ratio. While deficiency P caused leaf width above tassel of maize decreasing till 16% and

Table 1. Soil analysis before planting lines adaptation test on acid soil, Tappalang, Mamuju West Sulawesi DS2010.

Measurement	Value	Criterion
Texture		
-Clay	68	Clay
- Silt	17	
- Sand	15	
pH H ₂ O (1:2,5)	4.95	Acid
pH KCl (1:2,5)	4.09	
C Organic (%)	1.02	Low
Total N (%)	0.19	Low
C/N	10.63	Low
P Bray I (ppm)	0.74	Very Low
K dd (me/100 g)	0.72	Moderate
Ca dd (me/100g)	25.32	High
Mg dd (me/100g)	1.39	Low
Na dd (me/100g)	0.17	Low
H ⁺ (me/100g)	0.54	-
Al-dd*me/100g)	5.27	-
Al Saturated (%)	21.4	Moderate
CEC (me/100g)	41.62	High
Base Saturated (%)	66.52	High

18% of first leaf under tassel (Bruno *et al.* 2000), Advanced reported that P as role key of morphogenetic and leaf development process in maize growth. Initial effect of P deficiency on dynamic leaf PAR absorption less than 7-18%. Deficiency P accelerate leaf senescence about 15-33% especially in grain filling period.

Climate Condition

Rain fall is the one important climate element and directly affected of plant development. In addition rain fall at research location (chart 1) quite enough to support normal growth and grain yield of maize. This site is suitable to produce maize every time due to rain fall distributed each month in a year. Usually rainy go down in the morning but sunshine in the afternoon due to research site include monsoon climate zone. Total rain fall in this area 3934 mm, meanwhile rainy 236 days in 2010. It was appropriate for maize development, especially planting in July-August and harvested November-December to fulfill rare maize stock in that period. We know that lag water became restricted maize production in the other site especially in dry land. Lakitan (2002) reported that water mobility carry out nutrients from soil to plant by initial step absorption water by tip root through endodermis, from endodermis cell moving to xylem by osmosis process then water moving to stem and leaf xylem. Maize adapted and produce optimum in dry land that 57 cm rain fall and distributed during planting season without irrigated at temperature 21-27 °C (Sprague 1988).



Chart 1. Rain fall and rainy day at research location, Tappalang Mamuju West Sulawesi, 2010.

Vegetative Growth of Maize

Hybrid maize lines and cultivar where adaptation tested on acid soil at TappalangMamuju Regency West Sulawesi is good enough. Showed in plant height achieved vary from 221.7- 278.3 cm. All hybrids line where growing have plant high more than 240 cm except MM 6 is advantage to developas produce biomass for feed. In this area we found a lot of cow mean while natural grass is limited.

Ear hight range from 94.0-140.3 cm. In generally ear position on the middle of plant height that indicated normal growth of maize lines. Sukmaragahighest plant ear and significantly different compared to hybrids linewhere tested. Too high ear position caused by difficult in harvesting and susceptible collapse by wind (Table 2).

Plant age for 50% tasselingvary of42.0-47.3 mean while silkingof 45.3-50.3dap. Nearly all of hybrid maize lineswhere tested not significantly different to AS-1 cultivar chek. It mean that lines included early maturity. The same case to Sukmararaga as acid tolerant cultivar check that means whole lines were tested tolerant acid soil. AnthesisSilking Interval (ASI) is 2-4 daysrange. It's still good enough for those lines where tested caused by the optimum maize grain yield obtain on ASI is 1-3 days (Becket *al.* 1996)

Grain and It's Components

Early maturity acid tolerance hybrid maize lines were tested on acid soil in TappalangMamuju West Sulawesi gave grain yield of 6.44-8.05 t/ha that 1000 grain weight 267.5-284.5 g, ear long 17.06 cm -18.23 cm and ear diameter 14.63 cm -18.23 mm. We found 5 hybrid lines as early maturity acid soil tolerance maize variety candidate, where potential to develop in acid soil. Those lines gave grain

Table 2. Plant hight, age of tasseling, silking and husk cover of early maturity acid tolerance maize lines Mamuju, West Sulawesi, 2010.

Lines/ cultivar	Plant height (cm)	Ear height (cm)	Tasseling 50% (days)	Silking 50% (days)
GM1	250.3 bc	112.0 bc	44.3 c	47.6 ef
GM2	248.3 bc	110.3 bc	42.6 c	46.7 ef
GM3	246.7 bcd	104.6 bcd	45.6 a	48.3 abc
GM4	234.6 cd	94.3 bcd	42.0 c	46.0 f
GM5	257.0 abc	99.0 bcd	42.3 c	45.3 ef
GM6	221.7 d	94.0 cd	44.7 bc	47.3 cd
GM7	236.0 bcd	103.7 bcd	43.3 c	46.7 de
GM8	244.0 bcd	115.0 bc	46.0 ab	48.3 bc
GM9	261.3 ab	112.3 bc	46.3 a	50.0 a
AS-1	244.6 bcd	81.0 d	42.3 c	46.3 a
Bima-3	260.3 abc	120.0 ab	47.3 a	49.0 ab
Sukmaraga	278.3 a	140.3 a	47.0 c	50.3 cd
CV(%)	5.3	12.3	3.1	3

more than 7 t/ha and not significantly different to AS-1 and Bima-3Bantimurung as early maturity check and Sukmaraga also as acid tolerant cultivar check. Those lines ie:GM1 (8.05 t/ha), GM2 (7.70 t/ha), GM3 (7.99 t/ha), GM8 (8.15t/ha) and GM9 (7.90 t/ha).

Grain yield in this research was high enough due to 21.40% Al saturated quite low (Table 1) it is not adequate strong influence to maize lines where tested. Therefore those lines necessary tested in higher Al saturatedsoil. Maize could be produce high grain until 40% Al saturated of soil (Kamprath 1970). Fertilizer Where applied especially N and P could be effective and available to plant due to supporting a good vegetative growth and grain yield. Applied N is high enough to accelerate vegetative growth and dark green leaf of plant (Foth 1994). Hardjowigeno (2007) reported that N role in plant were accelerating vegetative growth and protein formation. While P role in plant were blossom formation, grain formation, maturity accelerated,stem and root strengthening, carbohydrate metabolism and transfer energy for instance ATP (*Adenosin Triphosphate*) and ADP (*Adenosin Diphosphate*).

Important Trait of Stakeholders

Plant performanceis very important predominantly of promoting new variety to stakeholder. Performance of early maturity acid tolerant hybrid lines before harvesting is good enough due to scoring value vary 1.66-4.00. There were two early maturity acid tolerant hybrid lines not significantly different to AS-1 ie: GM1 and GM8, both of

Table 3. Grain and yield component of early maturity acid tolerance line maize, Mamuju, West Sulawesi 2010.

Lines/ cultivar	Grain (t/ha)	1000 grain weigh (g)	Ear long (cm)	Ear diameter (cm)
GM1	8,05 a	272,7 bc	16,93 d	4,85 b
GM2	7,70 a	270,0 bc	18,03 ab	5,98 a
GM3	7,99 a	273,0 bc	16,86 d	5,27 b
GM4	6,72 bc	268,3 c	17,10 cd	4,99 b
GM5	6,75 bc	269,7 bc	16,73 d	4,96 b
GM6	6,60 bc	272,6 bc	17,50 abcd	4,65 b
GM7	6,44 c	289,3 bc	17,06 cd	4,97 b
GM8	8,15 a	267,3 c	18,20 a	4,83 b
GM9	7,90 a	284,3 a	18,23 a	4,82 b
AS-1	7,83 a	277,3 ab	17,90 abc	5,17 ab
Bima-3	7,30 abc	272,7 bc	17,27 bcd	4,99 b
Sukmaraga	7,42 ab	281,6 a	18,16 a	5,19 ab
CV (%)	7	2,7	3	1,2

them is the best performance category by scoring value is lowest compared to the others hybrid lines. Meanwhile Sukmaraga as acid tolerant cultivar check have score(4). The scoring (1) is the best and the contrary (5) is the bad category performance.

Husk cover of hybrid maize lines which adaptation tested showed that there are few lines have score value ≤ 3ie: GM1(1.33), GM2(2.63),GM3(1.33),GM8(1.33) and GM9(1.33) have good husk cover. There were 3 hybrids maize lines that hush cover scoring value ≥ 3,those lines is GM5(3.33%), GM6(3.33%) and GM7(3.00). and only one line (GM 5) has scoring value (5) is bad category and significantly different with the other hybrid lines. Seed companies in generally not attracted to growing varieties where have bad husk cover, consequently pest invested grain yield quickly since in the field especially *Sitophilus sp.*

Hybrid lines as candidate varieties where tested on acid soil in the second planting time at Mamuju West Sulawesi rendemendachieved vary from 77.6-80.7%. Whole lines were adaptation tested not significantly different to early maturity and acid tolerant cultivar check. Rendemend of maize lines which tested were good enough due to significantly different compared to early maturity (AS-1) and acid tolerant cultivar check(Sukmaraga). Whole of hybrid linesrendemendnearby 80% that value used in formula to calculating maize grain yield in a hectare size.

Table 4. Plant performance, husk cover and rendemendof early maturity acid tolerant line maize, Mamuju, West Sulawesi. 2012.

Line/cultivar	Plant performance (scoring)	Husk cover (scoring)	Rendemend (%)
GM1	1.67 d	1.33 c	79.5 ns
GM2	3.66 ab	2.67 b	78.7
GM3	2.67 bcd	1.33 c	77.6
GM4	3.66 ab	3.33 b	78.5
GM5	3.66 ab	5.00 a	79.9
GM6	3.33 abc	3.33 b	78.2
GM7	2.67 bcd	3.00 b	78.7
GM8	1.66 d	1.33 c	78.5
GM9	2.33 dc	1.33 c	79.1
AS-1	1.67 d	1.00 c	80.7
Bima-3	3.00 abc	2.67 b	78.2
Sukmaraga	4.00 a	1.00 c	79.1
CV (%)	3.4	3	2.1

Conclusions

Research results that found 5 lines as hybrid variety candidate of early maturity acid soil tolerant maize. Grain yield potential more than 7 t/ha and not significantly different to AS-1 (7.83 t/ha)and Bima-3Bantimurung (7.30 t/ha) as the early maturity and Sukmaraga(7.42 t/ha) as acid soil tolerant cultivar check. Those promising lines were GM1 (8.05 t/ha), GM2(7.70 t/ha), GM3(7.99 t/ha),GM8 (8.15 t/ha) and GM9 (7.90 t/ha).

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